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13. ABSTRACT *(Maximum 200 words)*

Transient vibrations of long flexible and gas-propelled guns are studied. The effects of transverse shear and rotary inertia in the cylindrical shell are included. The vibrations at any point is nill before the arrival of projectile and is followed by a sudden high frequency large amplitude radial response which then decays

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DYNAMIC INSTABILITY & TRANSIENT VIBRATIONS IN GAS–PROPELLED GUNS

FINAL TECHNICAL REPORT

IRADJ TADJBAKHSH

FEBRUARY 15, 1992

U.S. ARMY RESEARCH OFFICE

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A. Problem Statement

In the first part of this study the gun tube is modeled as a flexible cylindrical shell with the effects of transverse shear and rotary inertia retained in the theoretical description. The projectile is modeled as a rigid body which rides on the gun tube and is driven by the expanding pressure front. Each body is governed separately by the laws of motion and the reaction forces that act between them. The interaction is considered to be that of two bodies that exert forces upon each other that are normal to the surface of contact. This type of interaction gives rise to forces acting on the projectile that depend upon the deformation of the cylinder. The reaction on the cylinder may be thought of as a traveling force whose magnitude, as well as position, depend upon the deformation. Thus the problem is nonlinear even in the context of linear shell theory.

B. Summary of the Most Important Results

Transient vibrations in the flexible gun tubes of gas–propelled hypervelocity gun was successfully analyzed employing Galerkin procedure and numerical integration of nonlinear initial value problems. In the hypervelocity range when the speed of the pressure front is faster than the critical velocity of the cylindrical shell, the nature of vibration changes significantly. Qualitatively, the bending response is directly proportional to the velocity and mass of the projectile. Quantitatively, the bending deflection is of the order of $10^{-1}\ell$ which is negligible in most cases.

The response of the system is dominated by the rotationally symmetric mode. A resonant phenomenon occurs when the speed of the pressure front is near hypervelocity conditions. The peak value of the radial expansion and the resonant range depend on the acceleration of the projectile. Vibrations are wave–like, have a local character and decay exponentially after passage of the front.

C. List of All Publications

1. "The Transient Vibrations and Instability in Flexible Guns – I. Formulation," by Yuan–An Su and Iradj G. Tadjbakhsh, Int. J. Impact Engng., Vol. 11, No. 2, pp. 159–171, 1991.
2. "Transient Vibrations and Instability in Flexible Guns – II. Response Characteristics," by Yuan–An Su and Iradj Tadjbakhsh, Int. J. Impact Engineering, Vol. 11, No. 2, pp. 173–184, 1991.
3. "Optimal Coupled–Modal Control of Distributed Parameter System," by Iradj G. Tadjbakhsh and Yuan–An Su, ASME, Journal of Applied Mechanics, Vol. 56, No. 4, pp. 941–946, Dec. 1989.
4. "Optimal Control of Beams with Dynamic Loading and Buckling," by Yuan–An Su and Iradj Tadjbakhsh, ASME J. Appl. Mech., Vol. 58, No. 1, pp. 197–202, 1991.

D. List of Participants

Yuan–An Su, Ph.D. August 1991.

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